

J. P. Swensen, L. U. Odhner, B. Araki and A. M. Dollar, "Injected 3D electrical traces in additive manufactured parts with low melting temperature metals," *2015 IEEE International Conference on Robotics and Automation (ICRA)*, Seattle, WA, 2015, pp. 988-995.
doi: 10.1109/ICRA.2015.7139297

Abstract: While techniques exist for the rapid prototyping of mechanical and electrical components separately, this paper describes a method where commercial Additive Manufacturing (AM) techniques can be used to concurrently construct the mechanical structure and electronic circuits in a robotic or mechatronic system. The technique involves printing hollow channels within parts that are then filled with a low melting point liquid metal alloy that solidifies upon cooling to form electrical traces. This method is compatible with most conventional fused deposition modeling and stereolithography machines, and requires no modification to an existing printer, though the technique could easily be incorporated into multi-material machines. Three primary considerations are explored using the a commercial fused deposition manufacturing (FDM) process as a testbed: material and manufacturing process parameters, simplified injection fluid mechanics, and automatic part generation using standard printed circuit board software tools. As demonstration of the ability to embed circuit in RP parts, a differential-drive robot is printed, populated with discrete electronic components, and injected to create a fully functional robot.

keywords: {liquid metals;mechatronics;production engineering computing;rapid prototyping (industrial);robots;stereolithography;additive manufacturing;differential-drive robot;fused deposition modeling;injected 3D electrical traces;injection fluid mechanics;low melting temperature metals;mechatronics;printed circuit board software tools;rapid prototyping;stereolithography machines;Frequency division multiplexing;Liquids;Metals;Printers;Robots;Three-dimensional displays},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7139297&isnumber=7138973>

F. H. Riddle, "The production of Porcelain for electrical insulation — V," in *Journal of the American Institute of Electrical Engineers*, vol. 42, no. 8, pp. 853-863, Aug. 1923.
doi: 10.1109/JoAIEE.1923.6593484

Abstract: Forming the plastic clay body into the finished insulator shape prior to the firing to vitrification is of great importance. Among the methods used to accomplish this are: 1. Dust or Semi-dry Pressing 2. Plastic Forming 3. Casting. Dust pressed insulators are used chiefly in low-tension work. The prepared plastic body is dried out, dampened with a definite amount of water, pulverized and pressed in steel molds. The density of this product is not so great as that made in other ways, but accurately sized, difficult shapes can be made. Turning from pugged blanks, throwing and jiggering are processes in which the body is roughly shaped while in the plastic condition, and might be termed "plastic forming." Pieces formed this way are trued up or fettled while still damp but stiff enough to hold their shape. The most common method of shaping thin-walled insulators is with a hot press die. Here the plaster of paris mold, having the shape of the outside or top of the insulator, is placed on a horizontally revolving wheel, the plastic clay body being placed in the mold and carefully pressed down so as to conform with the mold. A heated metal part is forced down onto the clay in the revolving mold, and shapes the spinning clay into proper form for the bottom of the insulator. The hot metal causes steam to be formed from the water in the plastic clay body, and this acts as a lubricant, preventing the clay from tearing, and also making it possible to form extremely thin petticoats or walls. Casting is done by preparing the clay body with sufficient water and electrolytes to form a liquid (slip). This is poured into dry plaster of paris molds of proper shape. The plaster absorbs water from the clay, and allows it to stiffen and become firm enough to be handled when the mold is removed after a proper period of time. Properly prepared slip has no more water (hence no more shrinkage) than plastic body. Pouring in the liquid condition makes it possible to form heavy - iecees comparatively free from strains.

keywords: {Casting;Glazes;Insulators;Plastics;Porcelain;Shape;Turning},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6593484&isnumber=6593464>

Y. Fouad and B. M. Rabeeh, "Interface/interphase kinetics in Al/Mg metal matrix composite," *2012 International Conference on Engineering and Technology (ICET)*, Cairo, 2012, pp. 1-5.
doi: 10.1109/ICEngTechnol.2012.6396143

Abstract: Hot uniaxial pressing of 6082 Al-alloy and AZ31 magnesium alloy is applied in Al-Mg foil-foil technique symmetrical arranged. However, delamination is a major limitation of lamellar composite structure, an emerging methodology introduced with micro laminated and/or delocalized nano particulate interphase. Mitigation of crack as well as toughening mechanisms is an objective. Parametric study (temperature, pressure and holding time) established for the control of interface/interphase kinetics. Hot uniaxial pressing parameters as well as alloying elements have a dominant effect on the kinetic of interface/interphase formation. Lamellar metal matrix composites introduced with new micro laminated composite interphase. Diffusion along with alloy segregation induced the formation of localized metal flow along with the interface as well as, low melting depressant (LMD) Zn. However, LMD induced the localized interphase structure enriched with Al or Mg, Alloy segregation tends to reach eutectic point and induce liquid phase. The formation of localized eutectic liquid tends to form either nano composite structure or micro laminated composite in a solid state processing. Microstructural characterization, mechanical characterization is also established via optical microscopy scanning electron microscopy, energy dispersive X-ray spectroscopy and tensile testing. Chemical and mechanical bonding via inter diffusion processing with LMD are dominant for interphase kinetics. Mechanical characterization with interfacial shear strength is also introduced with hardness testing. HIPing processing is successfully applied on 6082 Al-alloy and AZ31 magnesium alloy for both particulate composite or micro-laminated composite processing. The interphase kinetic established through localized micro plasticity, metal flow, LMD and delocalized Al oxide and Mg oxide. The morphology of interphase is cached with interesting structures that need more studies.

keywords: {X-ray chemical analysis;aluminium alloys;bonds (chemical);chemical interdiffusion;delamination;eutectic alloys;hardness testing;hot pressing;interface structure;laminates;localised states;magnesium alloys;melting point;nanocomposites;nanoparticles;optical microscopy;particle reinforced composites;plasticity;reaction kinetics theory;scanning electron microscopy;shear strength;tensile testing;Al-Mg foil-foil technique;Al-Mg-Al;HIPing processing;alloy segregation;chemical bonding;crack mitigation;delamination;delocalized Al oxide;delocalized Mg oxide;delocalized nanoparticulate interphase;energy dispersive X-ray spectroscopy;eutectic point;hardness testing;induce liquid phase;interdiffusion processing;interfacial shear strength;interphase kinetic;interphase morphology;lamellar composite structure;lamellar metal matrix composites;localized eutectic liquid formation;localized interphase structure;localized metal flow formation;low melting depressant Zn;mechanical bonding;mechanical characterization;microlaminated composite;microlaminated nanoparticulate interphase;microplasticity;microstructural characterization;nanocomposite structure;optical microscopy;particulate composite;scanning electron microscopy;solid state processing;tensile testing;toughening mechanisms;Bonding;Delamination;Kinetic theory;Materials;Metals;Presses;Pressing;Composite;HIPing;Hybrid;interface;interphase;micro-laminated;particulate},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6396143&isnumber=6396105>

E. Baird and K. Mohseni, "Digitized Heat Transfer: A New Paradigm for Thermal Management of Compact Micro Systems," in *IEEE Transactions on Components and Packaging Technologies*, vol. 31, no. 1, pp. 143-151, March 2008.
doi: 10.1109/TCAPT.2008.916810

Abstract: This paper presents theoretical and numerical results describing digitized heat transfer (DHT), a newly developing active thermal management technique for high-power density electronics and integrated micro systems. In describing DHT, we numerically investigate the mass, momentum, and energy equations governing the flow within a translating microdroplet. Our analysis shows the existence of a pair of recirculation zones inside the droplet. This internal circulation within discrete fluid slugs results in significantly increased overall heat transfer coefficients when compared to continuous Graetz-type flows. The internal circulation drives the cold fluid in the middle of the droplet to the vicinity of the walls and creates a higher local temperature difference between the wall and the fluid in contact with the wall, resulting in higher heat transfer rates. Nusselt numbers characterizing DHT flow are also shown to exhibit periodic fluctuations with a period equal to the characteristic time scale for droplet circulation. The overall effect of discretizing a flow on heat transfer capability is described and characterized in terms of a nondimensional circulation number defined by the ratio of characteristic thermal diffusion and fluid circulation time scales. DHT coolants, including liquid metals and alloys, are proposed, and their physical properties are shown to enable handling of significantly higher heat transfer rates than classical air- or water-cooled methods. The actuation method for DHT coolant transport is also outlined, and shown to provide the capability for active, on-demand suppression of transient hot spots. This overall analysis defines the key parameters for optimization of the DHT method and forms the basis of ongoing experimental work.

keywords: {convection;coolants;drops;heat transfer;integrated circuit packaging;optimisation;thermal diffusion;thermal management (packaging);DHT coolant transport;Nusselt numbers;digitized convective heat transfer;discrete fluid slugs;energy equations;fluid circulation time scales;high-power density electronics;integrated compact micro systems;mass equations;microdroplet translation;momentum equations;optimization;packaging density;thermal diffusion;thermal management;transient hot spots;Circuits;Coolants;DH-HEMTs;Heat transfer;Microchannel;Packaging;Temperature;Thermal management;Thermal management of electronics;Thermal resistance;Convective heat transfer;Graetz problem;digitized heat transfer (DHT);electrowetting;thermal management},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4459753&isnumber=4459752>

S. Pourrahimi, C. L. H. Thieme and S. Foner, "Intermediate scale industrially processed Nb₃Sn(Ti) by powder metallurgy," in *IEEE Transactions on Magnetics*, vol. 25, no. 2, pp. 1964-1967, Mar 1989.
doi: 10.1109/20.92693

Abstract: Powder metallurgy processing of Nb₃Sn(Ti) wire was scaled up to 75-mm-diameter billets, each containing 4 kg of pressed powder composite. Prealloyed Nb-1.5-wt.% Ti powder was used for optimum high-field properties. An initial hot extrusion step provided complete consolidation and excellent integrity of the powder composite. Using the extruded bars, various single and multiple tin core billets were prepared and hydrostatically extruded to 12-mm-diameter bars. Long lengths of internal tin core wire were drawn without any breakage to less than 1 mm diameter. To evaluate the performance of long-length wires, small magnets were fabricated from these wires and tested in background fields of water-cooled Bitter magnets up to 20 T. The processing, performance, and microstructure of these small magnets are discussed. This intermediate-scale process used conventional metal-forming techniques that can be scaled to larger scale industrial processing

keywords: {crystal microstructure;drawing (mechanical);extrusion;niobium alloys;powder metallurgy;superconducting magnets;tin alloys;titanium alloys;type II superconductors;1 mm;12 mm;75 mm;Nb₃Sn;Nb₃Ti;complete consolidation;conventional metal-forming techniques;core billets;drawing;hydrostatic extrusion;initial hot extrusion step;intermediate-scale process;long-length wires;microstructure;optimum high-field properties;powder metallurgy;pressed powder composite;small magnets;water-cooled Bitter magnets;Bars;Billets;Magnetic cores;Magnets;Microstructure;Niobium;Powders;Testing;Tin;Wire drawing},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=92693&isnumber=3041>

B. Tejaswi, P. S. Sivasakthivel and M. Venkatesan, "Image processing algorithm for droplet measurement after impingement," *2016 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)*, Chennai, 2016, pp. 1-4.
doi: 10.1109/ICCIC.2016.7919580

Abstract: Droplet impingement cooling on flat surfaces finds its applications in spray cooling of hot surfaces, deposition of molten metal on surfaces, plasma coating, cooling of brake pad, turbine blade and in electronic chip cooling. Optimization of such a process requires a thorough understanding of the hydrodynamic process which happens during impingement of the droplet on the surface. Image processing techniques can be employed to understand the process. Image processing is converting an image into digital form and analyzing it, to get an improved image and extracting the desired information from it. The technique is widely used in face detection, remote sensing applications, machine vision and industrial robotics. In the present work an image processing algorithm is developed for a specific surface cooling technique. A hot surface is treated by impinging droplets. The size of the droplets can alter the material characteristics significantly. The objective of the present work is to develop an image processing algorithm to find the droplet dimensions. The variation in radius and height is examined with the help of Matlab software. Edge detection techniques are used to determine the boundaries of the droplet clearly. The algorithm is developed using Matlab toolbox and is capable of measuring droplet height and spreading radius in detail. The advantage of this algorithm is that the technique can be employed to the process in real time.

keywords: {coating techniques;cooling;drops;edge detection;hydrodynamics;image processing;liquid metals;optimisation;Matlab software;brake pad cooling;digital form;droplet impingement cooling;droplet measurement;edge detection techniques;electronic chip cooling;face detection;flat surfaces;hot surface spray cooling;hot surface treatment;hydrodynamic process;image processing algorithm;industrial robotics;information extraction;machine vision;molten metal deposition;plasma coating;process optimization;remote sensing applications;turbine blade cooling;Cooling;Heat transfer;Heuristic algorithms;Image edge detection;Software algorithms;Surface treatment;Height;droplet cooling;edge detection;image processing;spreading radius},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7919580&isnumber=7919507>

Y. Dong, Q. Man, J. Zhang, C. Chang, R. Li and X. Wang, "Fabrication of FePbNbCr glassy cores with good soft magnetic properties by hot pressing," *2015 IEEE Magnetics Conference (INTERMAG)*, Beijing, 2015, pp. 1-1.
doi: 10.1109/INTMAG.2015.7156861

Abstract: Summary form only given. Since Fe-based FeAlGaPCB bulk glassy alloy (BGA) was firstly synthesized in 1995 [1], a number of Fe-based BGAs have been developed [2-7] in last two decades. These Fe-based BGAs have relatively high GFA, which leading to the

formation of glassy alloy rods prepared by copper mold casting with much lower cooling rates than that of amorphous alloy thin ribbons produced by melt-spinning. However, their dimension is still restricted to be mm-order in diameters. The hot pressing process using glassy powder should be an alternative technique for the preparation of large-size BGAs. In this study, Glassy $\text{Fe}_{77}\text{P}_7\text{B}_{13}\text{Nb}_2\text{Cr}_1$ alloy powders were synthesized using raw materials in the particle size range below $100\text{ }\mu\text{m}$ by water atomization. The glassy powders were consolidated into cores with dimensions of 13 mm in outer diameter, 8 mm in inner diameter and 3 mm in thickness through sintering them at different temperatures under a pressure of 100 MPa by the hot pressing technique. Fig.1 shows the XRD patterns of the cores sintered at different temperatures. It can be seen that when the sintering temperature below 771 K, which was the glass transition temperature of the powder, only broad peaks without a crystalline peak can be seen, indicating the formation of a glassy single phase of the cores. While increasing the sintering temperature to above 791 K, it is crystallized and the phase is $\text{Fe}_3(\text{B,P})$, $\alpha\text{-Fe}$ and some unknown phase, which will destroy the soft magnetic properties of the cores. Table I summarizes the soft magnetic properties and core loss of the cores compressed at different temperatures. It can be seen that the core sintered at 771 K exhibits good soft magnetic properties, i.e., high saturation magnetic flux density B_s of 1.13 T, low coercive force H_c of 50 A/m, relative high effective permeability μ_e of 1200 at 1 kHz under a field of 1 A/m, low core loss P of 25.8 W/kg at 10 kHz under the maximum magnetic flux density of 0.1 T. The synthesis of Fe-based glassy cores with good magnetic properties is encouraging for future applications as functional materials.

keywords: {X-ray diffraction;boron alloys;casting;chromium alloys;coercive force;glass transition;hot pressing;iron alloys;magnetic permeability;metallic glasses;niobium alloys;phosphorus alloys;sintering;soft magnetic materials; $\text{Fe}_{77}\text{P}_7\text{B}_{13}\text{Nb}_2\text{Cr}$;XRD patterns;bulk glassy alloy;coercive force;copper mold casting;core loss;effective permeability;glass transition temperature;glassy alloy rods;glassy cores;hot pressing;saturation magnetic flux density;sintering;soft magnetic properties;water atomization;Core loss;Magnetic cores;Magnetic properties;Metals;Powders;Pressing;Temperature},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7156861&isnumber=7156490>

Y. Dong, Q. Man, J. Zhang, C. Chang, R. W. Li and X. M. Wang, "Fabrication of FePBNbCr Glassy Cores With Good Soft Magnetic Properties by Hot Pressing," in *IEEE Transactions on Magnetics*, vol. 51, no. 11, pp. 1-4, Nov. 2015.
doi: 10.1109/TMAG.2015.2446998

Abstract: Glassy $\text{Fe}_{77}\text{P}_7\text{B}_{13}\text{Nb}_2\text{Cr}_1$ alloy powders with the particle size below $100\text{ }\mu\text{m}$ were synthesized by water atomization using industrial raw materials. The glassy powders were consolidated into bulk forms through sintering them at different temperatures by hot pressing. The resulting glassy core sintered at 771 K, which between the supercooled liquid region, has a high relative density of 91% compared with the master alloy. It also exhibits good soft magnetic properties, i.e., high saturation magnetic flux density B_s of 1.13 T, low coercive force H_c of 50 A/m, relatively high effective permeability μ_e of 1200 at 1 kHz under a field of 1 A/m, low core loss P of 1393 mW/cm^3 at 50 kHz under the maximum magnetic flux density of 0.1 T. The synthesis of Fe-based glassy cores with good soft magnetic properties is encouraging for future applications as functional materials.

keywords: {boron alloys;chromium alloys;coercive force;dissociation;eddy current losses;hot pressing;iron alloys;magnetic flux;magnetic particles;magnetic permeability;metallic glasses;niobium alloys;particle size;phosphorus alloys;powders;sintering;soft magnetic materials;sprays;supercooling; $\text{Fe}_{77}\text{P}_7\text{B}_{13}\text{Nb}_2\text{Cr}$;bulk forms;frequency 1 kHz;frequency 50 kHz;functional materials;glassy alloy powders;glassy cores;high effective permeability;high relative density;high saturation magnetic flux density;hot pressing;industrial raw materials;low coercive force;low core loss;magnetic flux density 1.13 T;master alloy;particle size;sintering;soft magnetic properties;supercooled liquid region;temperature 771 K;water atomization;Core loss;Glass;Magnetic cores;Magnetic properties;Metals;Powders;Pressing;Amorphous powder;Fe-based alloy;amorphous powder;hot pressing;magnetic properties},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7131547&isnumber=7305868>

E. Y. Rapoport and Y. E. Pleshivtseva, "Combined optimisation of metal hot forming line with induction pre-heating," *2010 IEEE 26-th Convention of Electrical and Electronics Engineers in Israel*, Eliat, 2010, pp. 000486-000490.
doi: 10.1109/EEI.2010.5662172

Abstract: This paper discusses a system approach for combined optimization of metal hot forming manufacturing line with induction pre-heating. This system approach takes into consideration the whole sequence of the interrelated technological operations including billet heating by induction, its cooling during transportation and subsequent plastic deformation during hot working. All these subsequent processes will be considered as a technological complex and combined optimization criteria will be used for its optimization. Depending upon application, metal hot working operations may be represented by forging, rolling, stamping, upsetting, extrusion and other operations where metal undergoes plastic deformation.

keywords: {billets;forming processes;induction heating;plastic deformation;billet heating;combined optimisation;extrusion;forging;induction pre-heating;interrelated technological operations;metal hot forming manufacturing line;metal hot working operations;plastic deformation;rolling;stamping;transportation;upsetting;Billets;Electromagnetic heating;Optimization;Presses;Productivity;Temperature distribution;Combined optimisation;Cost function;Hot forming;Induction heating;Maximum productivity;System approach},

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S. A. E. Buxton, "Electrical drives and automation for continuous casting of steel," in *Electronics and Power*, vol. 21, no. 20, pp. 1131-1134, November 27 1975.
doi: 10.1049/ep.1975.1167

Abstract: Continuous casting of the formation of billets, blooms and slabs direct from the liquid metal was first attempted in 1856 when Bessemer poured molten steel between water-cooled rolls to try to form continuous sheets of thin plate. Owing to the high temperatures involved and the low conductivity of steel when hot, difficulties were encountered, and it is only in the last 20 years that these difficulties have been overcome, so that high-production units for the continuous casting of steel could be developed

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5181972&isnumber=5181945>

M. N. Salmanov, N. S. Salmanov and V. B. Butigin, "About the physical-chemical theory dispersion hardening of metal-working tool working surfaces," *Modern Techniques and Technology, 2000. MTT 2000. Proceedings of the VI International Scientific and Practical Conference of Students, Post-graduates and Young Scientists*, Tomsk, 2000, pp. 172-173.
doi: 10.1109/SPCMTT.2000.896104

Abstract: The research of tribotechnical phenomena occurring in a working area of the tool (punches of heat deforming press and cutting

tool) under exploitation appears to be of great significance due to problems of its reliability and durability. These factors depend on properties of new phases which are formed in a working contact zone as a result of cyclical temperature and power effects, and also from interaction with products of tribodestruction of greasing-cooling liquids (GCL). Starting from the above, the purpose of research was the analysis of the origin of self-influence of chemical composition of the GCL. The tool reliability and durability depends on properties of chemical connections formed on working surfaces of the tool. The creation of more plastic and tear-proof chemical connections (phases) on working surface decreases chipping and wearing of the tool. Physico-chemical theory dispersion of hardening allows us to select the most effective fixed methods of chemical-thermal processing and depositions of coatings depending on conditions of activity of the tool

keywords: {cooling;cutting;dispersion hardening;lubrication;machine tools;reliability;wear resistance;chemical composition;chemical connections;chemical-thermal processing;chipping decrease;coatings;cutting tool punch;cyclical temperature;dispersion hardening;durability;greasing-cooling liquids;heat deforming press punch;lubrication;metal-working tool working surfaces;physical-chemical theory;plastic chemical connections;power effects;reliability;tear-proof chemical connections;tribodestruction;tribotechnical phenomena;wear decrease;working contact zone;Chemical analysis;Cutting tools;Electrons;Hydrogen;Iron;Nitrogen;Plastics;Surface cracks;Surface resistance;Temperature dependence},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=896104&isnumber=19400>